Rocky Intertidal Ecological Monitoring In Channel Islands National Park, California 1982-83

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ROCKY INTERTIDAL ECOLOGICAL MONITORING

ABSTRACT

Rocky intertidal communities are monitored at 11 locations on four islands in Channel Islands National Park. Eight of these monitoring sites were new in 1985. High and mid-intertidal zones are monitored each spring and fall using permanent photoquadrats. Permanent black abalone plots were established in 1985 to monitor these economically important species. Photoquadrat data show seasonal fluctuations in acorn barnacles, rockweed and turfweed. Data since 1982 from Anacapa Island show a major decline in turfweed cover after the 1983 El Nino. Populations have not returned to pre El Nino levels. Disturbance from an accidental barge grounding on Santa Barbara Island is providing an opportunity to document natural response to impact in two intertidal zones. Damage is still apparent more than three years after experimental trampling and scraping quadrats at Anacapa Island in mussel and rockweed zones. Observations at South Frenchy's Cove on Anacapa Island, the most heavily visited intertidal area in the park, show damage to the lower algal zones. Animals such as large anemones and abalone are rare or absent at the site. Recommendations are made for further monitoring and ways to reduce visitor impact.

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INTRODUCTION

The intertidal zone is the transition between sea and land, It is a dynamic area subjected to diurnal fluctuations of tides and pounding surf. Many of the organisms living there are specially adapted to this environment. Tidepools act as a window to the sea, allowing visitors a close up view of marine life normally inaccessable to them. The Channel Islands harbor the last undisturbed tidepools in Southern California, representing the mainland intertidal of the past.

Despite the intertidal community's resistance to alternate exposures of drying sun and pounding surf, it is vulnerable to impact by humans. Careless visitors can cause damage through trampling, rock turning, or removal of organisms. Complete recovery from these kinds of impact may take many years. Pollution is also a major threat to intertidal biota. This zone is particularly vulnerable to major oil spills. Because this zone is fragile and is a major nationally significant ecosystem in Channel Islands National Park, it is important to monitor its condition.

Baseline studies of the Southern California intertidal were done in the late 1970's under a contract by the Bureau of Land Management (BLM) (Littler, 1979a,b,c; Littler and O'brien, 1978; Littler and Martz, 1979; Kanter, 1979; Seapy and Littler, 1978). Assessments of visitor impact at South Frenchy's Cove were made by Littler (1978) under contract to the National Park Service.

In 1982, VTN Oregon, Inc. was contracted to design a rocky intertidal monitoring program for Channel Islands National Park (VTN, 1983). As part of the monitoring, stations were established at Anacapa Island. At South Frenchy's Cove and Middle Anacapa-West, stations were established to monitor visitor impact in the most frequently visited areas. For comparison, control quadrats were established at Cat Rock and Middle Anacapa-East, two less frequently visited areas which have similar environmental conditions to the visitor use sites. At each site, abundance of selected dominant organisms representing different intertidal zones was monitored by photographing fixed quadrats periodically. In 1985, additional photoplots were established at Santa Barbara, San Miguel and Santa Rosa Islands. Additionally, fixed plots to monitor black abalone, Haliotis cracherodii, abundance and size frequency distributions were established on Anacapa, Santa Barbara, San Miguel and Santa Rosa Islands in 1985.

Four major zones were monitored with photoquadrat ' s. The barnacle zone is highest and generally dominated by the acorn barnacle Chthamalus fissus/dalli. Other acorn barnacles, mostly Balanus glandula and Tetraclita rubescens, are common in this zone at some sites. The turfweed zone occurs below the acorn barnacle zone, and is dominated by the low turf-like red alga, Endocladia muricata. The rockweed zone is mid-intertidal and often completely covered by the brown alga Pelvetia fastigiata, Hesperophycus harveyanus is another rockweed in this zone at some sites. The mussel zone is the lowest zone monitored.The mussel Mytilus californianus, is dominant. The mussels often compete for space with gooseneck barnacles, Pollicipes polymerus, and coralline algae, Corallina spp. Because of the absence of Endocladia at the Santa Barbara Island Landing Cove site, an additional zone of red algal turf was monitored there because of its' dominance of the lower rock shelf. The red algal turf forms a distinct and important zone below the rockweed zone and is dominated by Gigartina canaliculata and Gelidium spp.

The goal of the intertidal monitoring program is to provide information on natural and human influenced changes in abundance and distribution of indicator organisms which may be used for management decisions regarding visitor use and impact in intertidal ecosystems. Monitoring key species of the intertidal ecosystem allows detection of major trends with affordable efforts, a sort of early warning system for the health of the ecosystem. Data from long-term monitoring programs such as this are important in establishing normal limits of variation (dynamic baseline conditions) and detecting and determining the extent of damage in this ecosystem.

This document is the first report since the National Park Service began intertidal monitoring at the Channel Islands. It presents data from 19821985.

METHODS

Monitoring sites have been established at 11 locations on four islands in Channel Islands National Park (see Fig. 1). The sites were chosen to represent typical bedrock intertidal communities in the park. Detailed site descriptions are given in the Intertidal Monitoring Handbook (Richards and Davis, inprep). Monitoring sites at Cat Rock, South Frenchy's Cove, Crook Point, and Cuyler Harbor are located at BLM baseline study sites (Littler, 1979b,1979c; Littler and O'Brien,1978; and Littler and Martz, 1979).

Each monitoring site consists of at least 5 permanently marked photoquadrats in each monitored zone, and five black abalone plots. At most sites, four zones are represented, but the Santa Rosa Island sites are exceptions with only three zones. Five 50 x 75cm photoquadrats were established in each of the four zones (see Intertidal Monitoring Handbook for detailed methods). Color 35mm slides were taken of each quadrat twice each year, in spring (Mar- May) and fall (Oct- Dec). The percent cover of indicator organisms, bare rock, and tar was estimated by projecting the slide onto a 100 point grid and scoring whatever was located at each point. At West Anacapa Island, Cat Rock, nine quadrats were established in each zone, three for each of three treatments; trample, scrape, and control (VTN, 1984). Middle Anacapa is divided into two areas, East and West by an impassible surge channel. The western portion is accessible by visitors to the island.

The Anacapa stations were monitored in March and October 1982, May 1983, April and October 1984, March and November 1985. ' San Miguel Island was monitored in April and October 1985. Santa Rosa Island was established and monitored in December 1985. Santa Barbara Island stations were monitored in March 1985, October 1985 (Sea Lion Rookery) and January 1986 (Landing Cove).

There are five fixed black abalone plots at each site. Each plot was established around an aggregation of 30-100 abalone, and the plots varied in size from about 1 to 2m2. During each sampling period, all abalone within the plots are counted and measured. Size frequencies are reported in three size classes; juvenile <4.4cm, adults 4.4- 12.6cm, and adults >12.6cm (legally harvestable) (Leighton and Boolootian, 1963).

A project in cooperation with the California Department of Fish and Game involves tagging individual black abalone with stainless steel tags wired to the shells. This project was begun in the fall of 1985 at Anacapa and will

continue in 1986 at the other islands. By relocating tagged individuals, we will be able to measure growth and determine movement patterns.

RESULTS

The photoquadrat data presented In tables 1-14, are averages of percent cover for all quadrats in that zone at each station. The total number of points indicated for each zone reflects the number of identifiable points from a possible maximum of 100 points per quadrat. The total points also reflects the number of quadrats per zone. For example, Middle Anacapa Island (East) and Cat Rock have only three replicate quadrats per zone and can have only 300 points, whereas other sites with five quadrats per zone can have 500 points. Some slides were scored for the dominant species only. The graph in figure 2 shows abundances of only the dominant organisms at Middle and West Anacapa. Bare rock in this study includes rocks covered with blue-green algae or shells of dead mussels and barnacles.

Seasonal fluctuations in acorn barnacle cover can be seen in the data. Its percent cover generally increased in fall and decreased in spring samples. The overall cover remained constant on an annual basis at Anacapa (Fig 2).

The turfweed Endocladia muricata also varied seasonally. Turfweed declined at Santa Barbara and Sa el Islands in the fall (Tables 7-12) and Middle Anacapa turfweed cover decreased slightly in the fall (Tables 5&6). South Frenchy's Cove and Cat Rock showed an exception to this pattern, with Fall increases (Tables I and 2). A large decline in turfweed cover occurred in 1984 at all Anacapa Island sites subsequent to El Nino conditions (Fig 2). Endocladia virtually disappeared from all quadrats in spring, 1984 and began a slow return in fall, 1984.

Overall rockweed cover at all Anacapa sites has declined slightly since monitoring began in 1982. Rockweeds, primarily Pelvetia fastigiata, showed seasonal changes, with cover increasing in the fall at most stations. Cat Rock, South Frenchy's Cove and Landing Cove were exceptions with decreases in the fall of 1985. The southern exposure sites of San Miguel and Santa Rosa Islands have sparse rockweed cover. For example, Crook Point on San Miguel Island has approximately 20% rockweed cover in the densest part of the zone compared to over 70% coverage at other sites on the Island (Tables 7-10). Rockweed zones were not established at the two Santa Rosa island sites because it only occured along that coastline on very protected east facing rocks.

At the Santa Barbara Island Landing Cove site, the red algal turf remained constant, with nearly 100% cover in three of the quadrats. The observed decline in the fall turfweed cover was a direct result of damage in two quadrats during dock construction in the summer of 1985 (Table 12). The construction barge was grounded on the rocky shelf, scraping off the top layer of rock and all living cover (McCluskey, Pers. Comm.). The two logt quadrats were relocated in their original locations and reestablished in January 1986. Dominant cover in these two quadrats was a combination of weedy algal species (Colpomenia sinuosa/perigrina and filamentous algae).

Seasonal declines of the mussel Mytilus californianus were generally accompanied by increased acorn barnacle and/or algal coverage (Tables 1-11).

Corallina sp., Ulva sp., Porphyra perforata and, to a lesser extent, Endocladia muricata were the most common algae among the mussels. Growth of barnacles and algae over the mussels may have obscured underlying mussels when, in fact, no decline in mussel cover occurred. Mussel decline at Santa Barbara Island Landing Cove (Table 12) was a direct result of flotsam damage during a winter storm. Logs or planks torn from the dock by waves at the landing cove apparently struck an area approximately 5m x 5m (McCluskey, pers. comm.).

After more than three years of recovery, damage is still evident among the experimentally impacted plots at Cat Rock (Tables 2-4, Fig. 2). Data in tables 2-4 are post treatment only. Both the mussel and rockweed zones show depressed levels of coverage in trampled quadrats and very low coverage with little recovery in scraped quadrats. Barnacle and turfweed areas recovered quickly from both trampling and scraping, and appear normal in treated quadrats compared with the control quadrats.

No major changes or trends were observed within the black abalone populations monitored during the first year (Table 15). Most abalone within the plots were between 4.4- 12.6 cm in size. 4.4cm is the size of maturity for black abalone (Leighton and Boolootian,1963), while 12.6 cm is the minimu legal harvest size in California.

DISCUSSION

It is clear that rocky intertidal communities in the park are part of a dynamic ecosystem with variability both seasonally and annually. Storms, water temperature, and juvenile recruitment are just a few of the many factors affecting seasonal variability (see Foster et al., 1986). Events such as El Nino, large scale storm damage, and chronic disturbance from visitation and pollution influence the system for many years following their occurrence. Unfortunately the specific effects of these events and activities are not easily or clearly defined. Some of the variability seen at the islands is discussed below.

The turfweed, Endocladia muricata holds much moisture and therefore is important as a low tide refuge for many animals. Turfweed is important for mussel settlement, as mussel larvae are attracted to chemicals produced by the algae (Dawson and Foster, 1982). Endocladia is usually crowded out of the lower zones by mussels, though it may occur growing on the shells of living mussels. It occurs fairly high in the intertidal and its seasonal decline in the fall may be a result of summer desiccation. The range of E docladia is centered to the north, indicating that it does not grow as well in warmer water. The decline of turfweed at Anacapa between spring 1983 and spring 1984 coincided with the peak of the El Nino event and may reflect decreased fitness of this algae in warm water. Turfweed appears to be fairly resistant to disturbance (VTN, 1983) and recovers quickly (Tables 3 and 4).

The rockweeds Pelvetia and Hesperophygus are perennial algae that, once established, will continue to dominate an area unless there is a major disturbance. The decrease seen in spring cover at most sites may reflect damage from winter storms. With such damage, the holdfast usually persists, and new branches will grow back in the summer. Severe damage from heavy trampling or complete scraping may cause a reduction in rockweed cover for several years (Tables 3 and 4). Quadrats at Cat Rock have shown no recovery

since the experimental scraping in 1982. Rockweeds are important cover for snails and other organisms during low tides. Hesperophycus harveyanus is endemic to Southern California and Baja California. Indications are that it is susceptible to oil spills (Dawson and Foster, 1982). Htsptr2phycus is the dominant rockweed at Harris Point, and occurs at other sites on San Miguel and Anacapa Islands.

Mussel quadrat data support casual observations that the Mytilus californianus populations are healthy. Both large and small individuals can be found at all sites. Mussels may have experienced several relatively predator-free years since El Niho when sea star populations declined (Davis, 1986), allowing many mussels to reach a large size. Epibiotic growth of acorn barnacles and algae on mussel shells make identification during slide scoring difficult, but probably does not affect mussel growth. It is possible in most photoquadrat slides to score for both mussels (the primary rockcover) and epibionts (algae and barnacles on mussel shells). No data are presented here for epibiotic growth; however, such information may be valuable in future work.

The log damage at Landing Cove (Santa Barbara Island) will provide an opportunity to watch recovery of a large area in the mussel zone. Experimental plots at Cat Rock indicate that complete clearings recover very slowly (Table 4). In addition to damage by logs and other debris, patches in the intertidal can be cleared by intense wave action (Dayton, 1971), human activity (Littler,1978), and sea otter foraging (Palmisano, 1983). Experimental photoquadrats show that mussels were fairly resistant to the onetime trampling (Table 3), but chronic trampling has eleminated mussels from heavy use areas (Engle, pers. comm.). Patch size, wave exposure, intertidal level, and the time of year are all important in affecting recovery rates, which may vary from a few months to many years (De Vogelare, 1985; Suchanek, 1985).

Acorn barnacles in the highest zone are essentially annual species**.** With regular recruitment, levels should not vary drastically unless there is continual disturbance. Barnacle numbers may actually increase after disturbance because of reduced competition with macroalgae and limpets.

Observations at South Frenchy's Cove indicated that the lowest intertidal zone, the red-turf algae zone was being impacted by visitation. An intertidal reef that is just a few hundred yards east of the monitoring site, but is relatively inaccessable, has dense growth of red algae (Gigartina canaliculata, Gigartina sp., Microcladia sp., Gelidium sp. Rhodoglossum affine and Gastroclonium coulteri) below the mussel zone. At the monitoring site, this zone is mostly coralline algae and filamentous red algae which is indicative of disturbance (Littler, 1978). Normally this zone would be dominated by Gigartina canaliculata, various other Gigartina species and Rhodoglossum affine. Paths worn through the algal cover can be detected on the tops of rocks in this area. Colonial anemones, Anthopleura elegantissima are common only on vertical rocks and in crevices at ihe visited site.

Discussions with Island Packers Company (IPCO) employees indicateed that much of the visitation by school groups at South Frenchy's Cove is at the rocky terrace west of the monitoring site known as the "Blow Hole". High school and college groups generally do not receive organized intertidal walks and wander freely, often walking as far as Cat Rock. This indicates that the

Frenchy's monitoring site may receive less visitation and the Cat Rock site may receive more visitors than previously thought.

RECOMMENDATIONS

Management action is required to reduce apparent visitor impacts to intertidal resources at Frenchy's Cove, Anacapa Island, and complete the monitoring network. Specifically, the following be done:

1. Stress importance of protecting intertidal resources in interpretive programs and concession training. Prepare brochures and wayside exhibits at Frenchy's Cove to inform visitors of the fragility of intertidal communities and appropriate etiquette for visiting this area.

2. Reduce trampling through the use of a trail system, guided walks or requiring visitors to wear soft sole shoes.

3. Conduct general species surveys every five years, of all monitoring sites (after Littler, 1978) to detect changes in species distribution in addition to the common species monitored.

4. Establish additional monitoring sites on Santa Rosa and Santa Cruz Islands.

5. Develop an automated data management system using Dbase III and SPSS/PC+.

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LITERATURE CITED

Davis, G. E. 1986. Kelp Forest Dynamics in Channel Islands National Park, California, 1982-1985. Channel Islands National Park and National Marine Sanctuary Natural Science Study Reports, Ventura, Calif. 11pp.

Dawson, E. Y. and M. S. Foster. 1982. Seashore Plants of California. Univ. of Calif. Press, Berkeley, Calif. 226pp.

Dayton, P. K. 1971. Competition, disturbance and community organization: the provision and subsequent utilization of space in a rocky intertidal community. Ecol. Monogr. 41: 351-389.

De Vogelaere, A. P. 1985. Effects of size, intensity, and edges of clearings on rocky intertidal succession. Abstract, Western Soc. of Nat. ann. meet. Monterey, California. December 1985.

Foster, M. S., A. P. De Vogelaere, C. Harrold, J. S. Pearse, and A. B. Thum. 1986. Causes of Spatial and temporal patterns in rocky intertidal communities of Central and Northern California. Minerals Management Service. Contract No. 1412-0001-30057. Los Angeles. 98pp.

Leighton, D. L. and R. A. Boolootian. 1963. Diet and growth in the black abalone, Haliotis cracherodii. Ecology 44(2):227-238

Littler, M. M. 1978. Assessments of visitor impact on spatial variations in the distribution and abundance of rocky intertidal organisms on Anacapa Island, California. United States National Park Service, Contract No. CX 8000-8-0010, Ventura. 161pp.

Littler, M. M. 1979a. Assessments of the distribution, abundance, and community structure of rocky intertidal organisms at the Northwest End of Frenchy's Cove, Anacapa Island, California. Science Applications, Inc. Tech. Rept. 11-1.12 to the BLM. Contract AA550-CT7-44 (Year III SCOCS Program), La Jolla. 40pp.

Littler, M. M. 1979b. Assessments of the distribution, abundance, and community structure of rocky intertidal organisms near the Cat Rock area of Anacapa Island, California. Science Applications, Inc. Tech. Rept. 11-1.13 to the BLM. Contract AA550-CT7-44,(Year III SCOCS Program), La Jolla. 40pp.

Littler, M. M. 1979c. Assessments of the distribution, abundance, and community structure of rocky intertidal organisms at the South Side of Frenchy's Cove, Anacapa Island, California. Science Applications, Inc. Tech. Rept. 1.22 to the BLM. Contract AA550-CT7-44 (Year III SCOCS Program), La Jolla. 48pp.

Littler, M. M. and P. Y. O'Brien. 1978, Biological Features of rocky intertidal communities near Cuyler Harbor, San Miguel Island, California. Science Applications, Inc. Tech. Rept. 111-2.1. Chapter Ten. pp813-902.

Littler, M. M. and D. R. Martz. 1979. Assessments of the disrtibution, abundance, and community structure of rocky intertidal organisms near Crook Point, San Miguel Island. Science Applications, Inc. Tech. Rept. 11-1.9 to the BLM. Contract AA550-CT7-44 (Year-III SCOCS Program), La Jolla. 43pp.

Kanter, R. 1979. Mussel community studies. Science Aplications, Inc. Tech. Rept. 11-7.0 to the BLM. Contract AA550-CT7-44 (Year-III SCOCS Program), La Jolla. 48pp.

Palmisano, J. F. 1983. Sea Otter predation: its role in structuring rocky intertidal communities in the Aleutian Islands, Alaska, USA. Acta Zool. Fenn. 174: 209-211.

Seapy, R. R. and M. M. Littler. 1978. Variations in the rocky intertidal biota near Cave Canyon, Santa Barbara Island, California. Science Applications, Inc. Tech. Rept. 111-1.1.4 to the BLM. Contract AA550-CT640, La Jolla. 57pp.

Suchanek, T. H. 1985. Slow recovery from disturbance in rocky intertidal mussel beds of Mytjlus californianus. Abstract, West. Soc. Nat. ann. meet. Monterey, Calif. Dec. 1985.

VTN, Oregon, Inc. 1983. Visitor impact and recovery on Channel Islands Tidepools: Final Report. National Park Service, Contract No. CX 8000-1-0054, Ventura. 80pp.

VTN, Oregon, Inc. 1984. Visitor impact on tidepools, field and laboratory handbook. National Park Service, Contract No. CX 8000-1-0054, Ventura, 26pp.

Table 1. Abundance of index species, tar, and bare rock at South Frenchy's Cove, Anacapa Island. 1982-85.

	BARNACLE ZONE								TURF WEED ZONE							
		PERCENT COVER								PERCENT COVER						
Sampling Period	Total Pts.	Bare Rock	Acorn Barn.	Turf Weed	Rock Weed	Mus-sels	Other Biota	Tar	Total Pts.	Bare Rock	Acorn Barn.	Turf Weed	Rock Weed	Mus-sels	Other Biota	Tar
Spring 82	500	41	54	4	0	0	1	0	490	28	8	59	3	0	1	0
Fall 82	395	28	50	20	0	0	1	<1	188	15	7	68	10	0	0	0
Spring 83	500	40	40	19	0	0	1	0	498	17	2	77	3	0	0	0
Fall 83	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Spring 84	491	64	36	0	0	0	0	0	461	96	4	0	<1	0	0	0
Fall 84	424	45	53	0	0	0	1	0	486	64	20	14	1	0	1	0
Spring 85	500	63	34	0	0	0	2	1	500	75	8	7	3	0	6	1
Fall 85	500	45	54	<1	0	0	1	0	481	61	21	13	2	0	3	0

	ROCK WEED ZONE								MUSSEL ZONE							
		PERCENT COVER								PERCENT COVER						
Sampling Period	Total Pts.	Bare Rock	Acorn Barn.	Turf Weed	Rock Weed	Mus-sels	Other Biota	Tar	Total Pts.	Bare Rock	Acorn Barn.	Turf Weed	Rock Weed	Mus-sels	Other Biota	Tar
Spring 82	499	8	0	<1	92	0	2	0	500	13	1	7	0	67	12	0
Fall 82	500	4	0	2	92	0	2	0	498	13	0	0	0	46	41	0
Spring 83	500	7	0	0	93	0	<1	0	500	11	0	1	0	58	31	0
Fall 83	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Spring 84	500	13	0	0	87	0	0	0	480	18	0	0	0	73	9	0
Fall 84	495	6	0	0	94	0	0	0	455	11	1	0	0	57	31	0
Spring 85	499	12	0	0	88	0	0	0	496	27	4	0	0	63	6	0
Fall 85	500	16	1	0	81	0	3	0	495	15	1	1	0	53	30	0

NA = Information Not Available
NS = Slides Not Scored

Table 2. Abundance of index species tar, and bare rock at Cat Rock (Control) Anacapa Island, 1982-85.

	BARNACLE ZONE								TURF WEED ZONE							
		PERCENT COVER								PERCENT COVER						
Sampling Period	Total Pts.	Bare Rock	Acorn Barn.	Turf Weed	Rock Weed	Mus-sels	Other Biota	Tar	Total Pts.	Bare Rock	Acorn Barn.	Turf Weed	Rock Weed	Mus-sels	Other Biota	Tar
Spring 82	293	55	39	6	0	0	0	0	297	23	NS	53	3	1	NS	0
Fall 82	296	52	31	15	1	0	0	<1	297	30	3	60	3	0	4	0
Spring 83	298	48	25	20	7	0	0	0	297	30	7	62	1	<1	<1	0
Fall 83	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Spring 84	289	72	21	0	4	4	0	0	285	85	11	2	3	0	0	0
Fall 84	262	65	31	0	4	0	0	0	238	NS	NS	6	NS	NS	NS	NS
Spring 85	296	70	27	0	3	0	0	0	300	72	21	4	2	1	0	0
Fall 85	300	57	38	1	5	0	0	0	298	65	15	15	2	2	0	0

	ROCK WEED ZONE								MUSSEL ZONE							
		PERCENT COVER								PERCENT COVER						
Sampling Period	Total Pts.	Bare Rock	Acorn Barn.	Turf Weed	Rock Weed	Mus-sels	Other Biota	Tar	Total Pts.	Bare Rock	Acorn Barn.	Turf Weed	Rock Weed	Mus-sels	Other Biota	Tar
Spring 82	296	19	5	8	68	0	0	0	198	36	NS	NS	NS	35	NS	NS
Fall 82	297	19	2	5	73	0	0	0	300	0	0	NS	NS	40	NS	NS
Spring 83	297	11	3	5	82	0	0	0	295	38	4	4	0	48	6	0
Fall 83	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Spring 84	296	19	3	0	78	0	0	0	277	43	15	0	0	42	0	0
Fall 84	290	NS	NS	NS	71	NS	NS	NS	241	NS	NS	NS	NS	39	NS	NS
Spring 85	284	22	3	<1	74	0	0	0	298	48	16	0	0	36	0	0
Fall 85	298	31	3	2	61	1	1	0	300	41	9	1	0	46	3	0

NA = Information Not Available
NS = Slides Not Scored

Table 3. Abundance of index species, tar, and bare rock at Cat Rock (Trample), West Anacapa Island, 1982-85.

	BARNACLE ZONE								TURF WEED ZONE							
		PERCENT COVER								PERCENT COVER						
Sampling Period	Total Pts.	Bare Rock	Acorn Barn.	Turf Weed	Rock Weed	Mus- sels	Other Biota	Tar	Total Pts.	Bare Rock	Acorn Barn.	Turf Weed	Rock Weed	Mus- sels	Other Biota	Tar
Spring 82	291	65	33	2	<1	0	0	0	294	47	18	35	0	<1	0	0
Fall 82	291	56	32	10	0	0	1	<1	288	25	20	52	1	0	2	0
Spring 83	299	56	28	16	0	0	0	0	297	31	10	56	0	<1	1	0
Fall 83	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Spring 84	290	73	27	0	0	0	0	0	283	76	20	4	0	0	0	0
Fall 84	266	62	38	0	0	0	0	0	281	NS	NS	6	NS	NS	NS	0
Spring 85	300	66	33	0	1	0	0	0	298	63	28	8	0	1	0	0
Fall 85	298	50	50	0	1	0	0	0	296	46	29	23	<1	<1	1	0

	ROCK WEED ZONE								MUSSEL ZONE							
		PERCENT COVER								PERCENT COVER						
Sampling Period	Total Pts.	Bare Rock	Acorn Barn.	Turf Weed	Rock Weed	Mus- sels	Other Biota	Tar	Total Pts.	Bare Rock	Acorn Barn.	Turf Weed	Rock Weed	Mus- sels	Other Biota	Tar
Spring 82	296	36	10	8	44	0	2	0	296	33	0	0	NS	31	0	0
Fall 82	295	28	4	12	57	0	0	0	300	NS	NS	NS	NS	22	NS	NS
Spring 83	298	22	3	23	52	0	0	0	299	53	6	6	0	29	6	0
Fall 83	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Spring 84	291	41	14	0	45	0	0	0	261	58	18	0	0	24	0	0
Fall 84	281	NS	NS	NS	46	NS	NS	NS	252	24	NS	NS	NS	NS	NS	0
Spring 85	279	49	13	0	38	<1	0	0	300	54	17	0	0	30	0	0
Fall 85	298	56	12	1	29	0	1	0	294	47	5	1	0	40	6	0

NA = Information Not Available
NS = Slides Not Scored

Table 4. Abundance of index species, tar and bare rock at Cat Rock (Scrape), West Anacapa Island, 1982-85.

Sampling Period	BARNACLE ZONE Total Pts.	PERCENT COVER Bare Rock	Acorn Barn.	Turf Weed	Rock Weed	Mus-sels	Other Biota	Tar	TURF WEED ZONE Total Pts.	PERCENT COVER Bare Rock	Acorn Barn.	Turf Weed	Rock Weed	Mus-sels	Other Biota	Tar
Spring 82	292	90	9	0	0	0	<1	0	294	88	2	8	1	0	1	0
Fall 82	298	86	11	3	<1	0	0	0	293	73	10	16	1	0	0	0
Spring 83	294	71	17	11	1	0	0	0	296	64	8	28	0	0	0	0
Fall 83	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Spring 84	261	69	31	0	0	0	0	0	278	88	12	0	0	0	0	0
Fall 84	248	42	50	0	7	0	0	0	279	NS	NS	3	NS	NS	NS	NS
Spring 85	299	56	32	0	12	0	0	0	298	78	18	2	1	0	0	0
Fall 85	299	33	49	0	17	0	1	0	298	64	19	14	0	0	3	0

Sampling Period	ROCK WEED ZONE Total Pts.	PERCENT COVER Bare Rock	Acorn Barn.	Turf Weed	Rock Weed	Mus-sels	Other Biota	Tar	MUSSEL ZONE Total Pts.	PERCENT COVER Bare Rock	Acorn Barn.	Turf Weed	Rock Weed	Mus-sels	Other Biota	Tar
Spring 82	299	87	4	1	8	0	0	0	300	93	2	2	0	3	<1	0
Fall 82	300	85	9	1	4	0	0	0	300	NS	NS	NS	NS	3	NS	NS
Spring 83	300	83	13	3	2	0	0	0	294	85	5	5	0	2	3	0
Fall 83	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Spring 84	294	71	23	0	6	0	0	0	281	87	13	1	0	0	0	0
Fall 84	300	NS	NS	NS	4	NS	NS	NS	300	NS	NS	NS	NS	0	NS	NS
Spring 85	294	64	30	0	6	0	0	0	296	73	18	0	0	8	0	0
Fall 85	292	59	34	1	5	0	1	0	300	71	12	2	0	5	10	0

NA = Information Not Available
NS = Slides Not Scored

Table 5. Abundance of index species, tar, and bare rock at Middle Anacapa, East Site 1982-85.

	BARNACLE ZONE								TURF WEED ZONE							
		PERCENT COVER								PERCENT COVER						
Sampling Period	Total Pts.	Bare Rock	Acorn Barn.	Turf Weed	Rock Weed	Mus-sels	Other Biota	Tar	Total Pts.	Bare Rock	Acorn Barn.	Turf Weed	Rock Weed	Mus-sels	Other Biota	Tar
Spring 82	193	79	12	7	0	0	2	0	287	42	5	44	6	0	2	0
Fall 82	286	63	24	9	0	0	4	0	290	32	4	50	11	1	2	0
Spring 83	296	53	17	13	0	0	17	0	292	16	1	53	21	0	8	0
Fall 83	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Spring 84	300	80	14	3	0	0	4	0	291	47	0	30	23	0	0	0
Fall 84	299	75	18	5	0	0	2	0	272	42	4	30	19	0	4	0
Spring 85	207	70	20	5	0	0	4	0	278	55	6	25	7	2	6	0
Fall 85	294	70	18	9	0	0	3	0	287	51	8	23	12	3	0	0

	ROCK WEED ZONE								MUSSEL ZONE							
		PERCENT COVER								PERCENT COVER						
Sampling Period	Total Pts.	Bare Rock	Acorn Barn.	Turf Weed	Rock Weed	Mus-sels	Other Biota	Tar	Total Pts.	Bare Rock	Acorn Barn.	Turf Weed	Rock Weed	Mus-sels	Other Biota	Tar
Spring 82	297	9	0	3	84	0	4	0	298	20	3	<1	0	72	5	0
Fall 82	297	6	1	<1	93	0	0	0	298	7	NS	NS	NS	71	NS	NS
Spring 83	296	7	1	3	88	0	2	0	298	16	3	1	0	78	2	0
Fall 83	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Spring 84	294	18	0	1	80	0	0	0	282	16	5	0	0	79	0	0
Fall 84	285	7	0	0	91	0	1	1	293	7	9	2	0	75	6	0
Spring 85	300	29	1	3	59	0	7	0	300	15	6	0	0	73	5	0
Fall 85	296	15	1	3	78	1	2	0	300	11	6	0	0	74	9	0

NA = Information Not Available
NS = Slides Not Scored

Table 6. Abundance of index species , tar, and bare rock at Middle Anacapa, West 1982-85.

Sampling Period	BARNACLE ZONE Total Pts.	PERCENT COVER Bare Rock	Acorn Barn.	Turf Weed	Rock Weed	Mus- sels	Other Biota	Tar	TURF WEED ZONE Total Pts.	PERCENT COVER Bare Rock	Acorn Barn.	Turf Weed	Rock Weed	Mus- sels	Other Biota	Tar
Spring 82	465	46	15	19	0	<1	20	0	475	42	7	43	0	<1	8	0
Fall 82	487	39	21	20	0	0	20	0	492	31	15	47	0	0	7	0
Spring 83	487	25	12	30	0	0	34	0	478	25	8	52	<1	<1	14	0
Fall 83	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Spring 84	480	55	17	7	0	0	21	0	478	76	14	9	0	1	0	0
Fall 84	420	63	24	5	0	0	7	0	409	76	13	7	0	<1	4	0
Spring 85	484	44	22	10	0	0	25	0	485	56	13	14	<1	<1	17	0
Fall 85	481	52	26	4	0	<1	18	0	499	56	14	13	<1	<1	16	0

+Sampling Period	ROCK WEED ZONE Total Pts.	PERCENT COVER Bare Rock	Acorn Barn.	Turf Weed	Rock Weed	Mus- sels	Other Biota	Tar	MUSSEL ZONE Total Pts.	PERCENT COVER Bare Rock	Acorn Barn.	Turf Weed	Rock Weed	Mus- sels	Other Biota	Tar
Spring 82	490	26	1	1	71	0	1	0	497	22	3	3	0	57	17	0
Fall 82	500	11	<1	2	83	0	3	0	496	16	NS	NS	NS	47	NS	NS
Spring 83	494	14	1	2	72	1	10	0	481	23	9	<1	0	58	10	0
Fall 83	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0
Spring 84	488	32	4	0	63	0	0	0	466	28	13	0	0	59	0	0
Fall 84	428	23	<1	0	70	0	7	0	408	22	8	0	0	59	12	0
Spring 85	467	24	3	1	57	0	15	0	500	25	17	<1	0	49	9	0
Fall 85	469	22	4	1	62	0	12	0	498	12	6	2	0	59	20	0

NA = Information Not Available
NS = Slides Not Scored

Table 7. Abundance of index species, tar, and bare rock at San Miguel Island, Culyer Harbor, 1985

Zone/ Period	Total Pts.	PERCENT COVER Bare Rock	Acorn Barn.	Turf Weed	Rock Weed	Mus- sels	Other Biota	Tar
BARNACLE								
Spring 85	500	57	41	2	0	0	0	0
Fall 85	498	54	44	2	0	0	0	0
TURF WEED								
Spring 85	500	38	8	51	<1	2	1	0
Fall 85	489	61	7	28	<1	2	2	0
ROCKWEED								
Spring 85	500	25	<1	2	71	<1	1	0
Fall 85	499	12	<1	2	81	0	5	0
MUSSEL								
Spring 85	500	3	<1	0	0	95	1	0
Fall 85	499	6	<1	<1	0	89	3	0

Table 10. Abundance of index species, tar, and bare rock at San Miguel Island, Crook Point, 1985.

Zone/ Period	Total Pts.	PERCENT COVER Bare Rock	Acorn Barn.	Turf Weed	Rock Weed	Mus- sels	Other Biota	Tar
BARNACLE								

Table 8. Abundance of index species, tar, and bare rock at San Miguel, Harris Point, 1985.

Zone/ Period	Total Pts.	PERCENT COVER Bare Rock	Acorn Barn.	Turf Weed	Rock Weed	Mus- sels	Other Biota	Tar
BARNACLE								
Spring 85	444	46	48	<1	<1	4	1	0
Fall 85	496	43	43	<1	0	7	<1	0
TURF WEED								
Spring 85	497	24	<1	66	7	<1	<1	0
Fall 85	485	73	3	15	8	1	<1	0
ROCKWEED								
Spring 85	397	18	0	11	70	0	0	0
Fall 85	390	17	2	3	79	0	0	0
MUSSEL								
Spring 85	500	13	1	<1	0	85	<1	0
Fall 85	500	11	2	0	0	87	<1	0

Table 11. Abundance of index species, tar, and bare rock at at Santa Barbra Island landing cove, 1985.

Zone/ Period	Total Pts.	PERCENT COVER Bare Rock	Acorn Barn.	Turf Weed	Rock Weed	Mus- sels	Other Biota	Tar
BARNACLE								
Spring 85	493	65	28	2	0	0	5	0
Fall 85	496	63	33	4	0	0	<1	0
RED ALGAE TURF								
Spring 85	491	3	<1	95	0	1	0	0
Fall 85	500	39	<1	55	0	0	6	0
ROCKWEED								
Spring 85	487	10	<1	0	84	0	6	0
Fall 85	476	18	<1	<1	68	<1	13	0
MUSSEL								
Spring 85	493	6	7	0	0	71	16	0
Fall 85	500	22	7	0	0	59	11	0

Table 12. Abundance of index species, tar, and bare rock at Santa Barbara Island Sea Lion Rookery, 1985.

Zone/ Period	Total Pts.	PERCENT COVER Bare Rock	Acorn Barn.	Turf Weed	Rock Weed	Mus- sels	Other Biota	Tar
BARNACLE								
Spring 85	500	70	25	3	0	0	3	0
Fall 85	492	78	21	1	0	0	0	0
TURF WEED								
Spring 85	465	35	6	57	3	<1	0	0
Fall 85	500	37	15	15	6	<1	26	0
ROCKWEED								
Spring 85	472	11	5	7	65	0	12	0
Fall 85	500	4	<1	1	90	0	4	0
MUSSEL								
Spring 85	433	9	66	<1	0	25	0	0
Fall 85	500	2	49	<1	0	31	16	0

Table 13. Abundance of index species, tar, and bare rock at Santa Rosa Island, Johnson's Lee

Zone Period	Total Pts.	PERCENT COVER Bare Rock	Acorn Barn.	Turf Weed	Rock Weed	Mus- sels	Other Biota	Tar
BARNACLE								
Fall 85	500	47	52	<1	0	0	<1	0
TURF WEED								
Fall 85	500	65	9	18	0	8	<1	0
ROCKWEED								
Fall 85	NA	NA	NA	NA	NA	NA	NA	NA
MUSSEL								
Fall 85	494	17	2	<1	0	69	8	0

Table 14. Abundance of index species, tar, and bare rock at Santa Rosa Island, Ford Point

Zone/ Period	PERCENT COVER							
	Total Pts.	Bare Rock	Acorn Barn.	Turf Weed	Rock Weed	Mus- sels	Other Biota	Tar
BARNACLE								
Fall 85	500	55	45	0	0	0	0	0
TURF WEED								
Fall 85	500	65	9	18	0	8	<1	0
ROCKWEED								
Fall 85	NA	NA	NA	NA	NA	NA	NA	NA
MUSSEL								
Fall 85	494	17	2	<1	0	69	8	0

Table 15. Abundance and size distribution (percent) of black abalone, Haliotis cracherodii, in fixed plots.

SAMPLING PERIOD	ISLAND							
	SANTA BARBARA	ANACAPA		SANTA ROSA		SAN MIGUEL		
SIZE CLASS[a]	Sealion Rookery	Cat Rock	Middle Island	Johnson's Lee	Ford Point	Crook Point	Harris Point	Otter Harbor
Spring 1985								
Juvenile	10	4	4	NA	NA	1	4	3
Sub-legal	75	75	82	NA	NA	76	82	59
Adult	15	21	14	NA	NA	23	14	38
Plot Total	170	287	527	NA	NA	455	383	529
Fall 1985								
Juvenile	0	1	10	2	0	3	19	8
Sub-legal	88	77	80	72	82	77	70	63
Adult	12	22	10	26	18	20	11	29
Plot Total	141	257	551	370	342	341	442	544

[a] Juvenile = Percent abalone < 4.4 cm maximum shell length, size of maturity;
Sub-legal = Percent abalone from 4.4 to 12.6 cm in size;
Legal = Percent abalone > 12.6 cm, minimum legal harvest size;
Plot total = number of black abalone within fixed plots.

NA = Information Not Available

FIGURE 1: Rocky Intertidal community monitoring site locations at Channel Islands National Park.

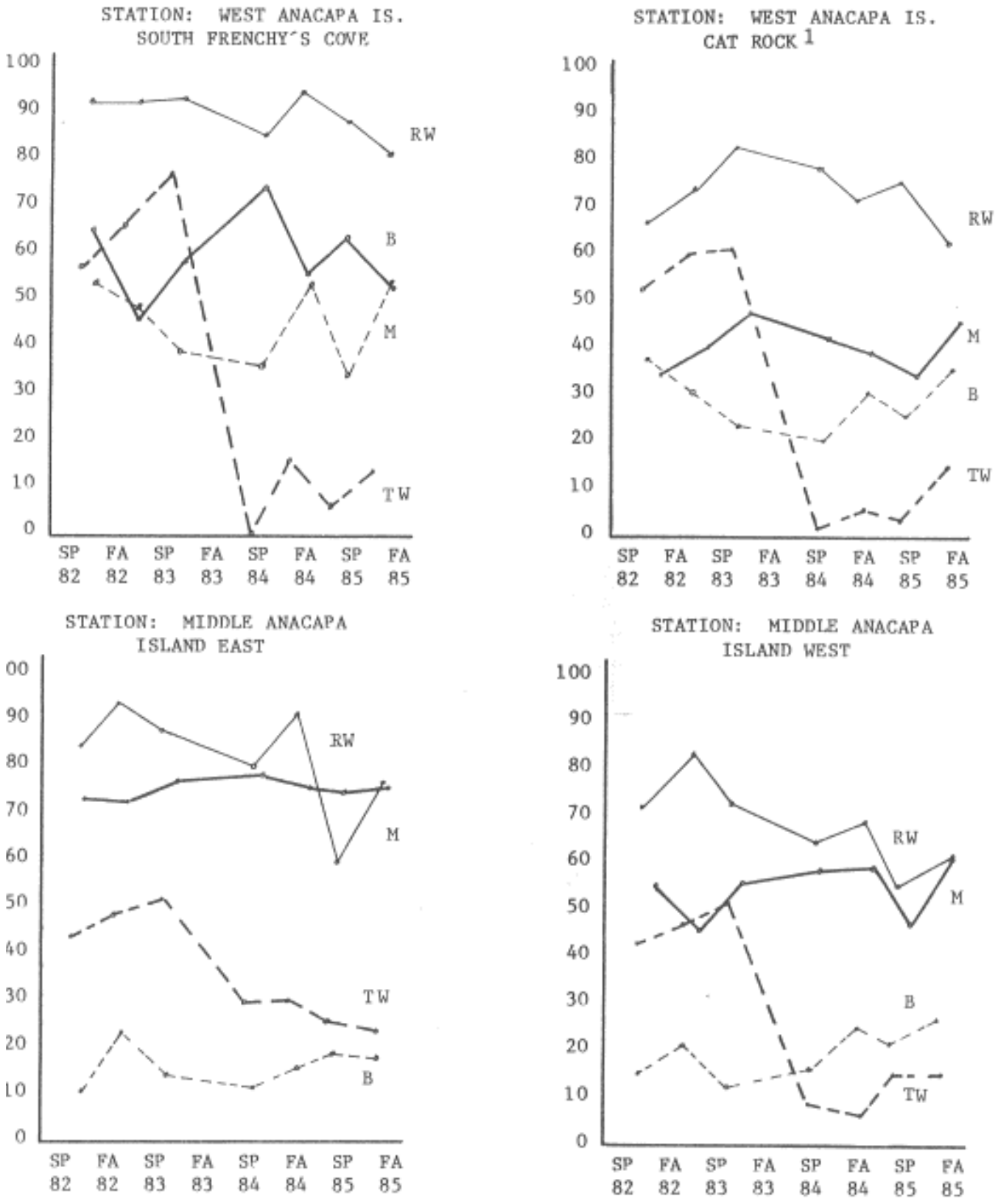

FIGURE 2. Abundance of index species dominant in each zone at Middle and West Anacapa Islands, 1982-1985. Rockweed (RW), Mussels (M), Barnacles (B), and Turfweed (TW)

[1] untreated quadrats off Cat Rock only